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DEPARTMENT : POLLUTION CONTROL AGENCY

STATE OF MINNESOTA

Office Memorandum

DATE : 09/16/2015

TO : File

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SUBJECT : Total phosphorus effluent limit review: Chippewa River Watershed

Introduction

The purpose of this memorandum is to provide an assessment of the need for a total phosphorus (TP) National Pollutant Discharge Elimination System (NPDES) permit limit for facilities that discharge to the Chippewa River Watershed. These facilities, collectively referred to as The Facilities, are identified in Table and Figure 1.

Montevideo WWTF is located downstream of the flow and water chemistry data used for this analysis (AUID 07020005-508) and Urbank WWTF has not discharged effluent during June – September via their surface discharge station in the last permit cycle (5 years). These operational details will be accounted for in the analysis.

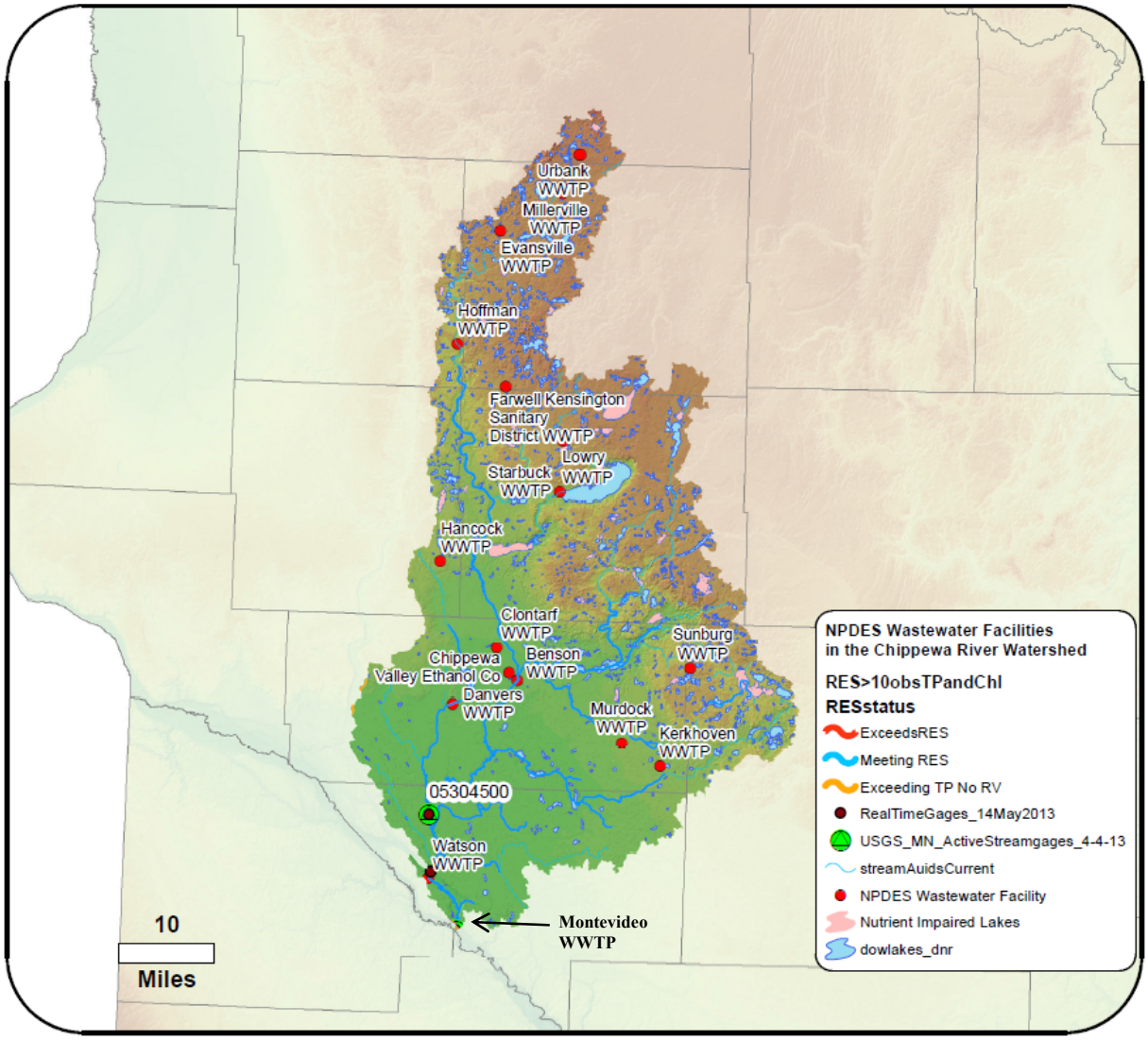
Table 1. NPDES permitted facilities in the Chippewa River Watershed.

Wastewater Treatment Facility	Permit #
Benson WWTF	MN0020036
Chippewa Valley Ethanol Co	MN0062898
Clontarf WWTF	MNG580108
Danvers WWTF	MNG580119
Evansville WWTF	MNG580074
Farwell Kensington Sanitary Dist WWTF	MN0065293
Hancock WWTF	MN0023582
Hoffman WWTF	MNG580134
Kerkhoven WWTF	MNG550010
Lowry WWTF	MNG580123
Millerville WWTF	MN0054305
Murdock WWTF	MNG580086
Starbuck WWTF	MN0021415
Sunburg WWTF	MNG580125
Urbank WWTF	MN0068446
Watson WWTF	MN0022144

A Chippewa River Watershed review for facilities upstream of the USGS flow gage near Milan, MN was completed in January 2014 (Lindon, 2014). The review was based on current actual loading from WWTFs and concluded that Lake Pepin limits were sufficient to meet water quality standards. In comparison, this memo will further analyze the watershed based on permitted loading potential, as a means to be more comprehensive when considering potential impacts on water quality.

Recently implemented phosphorus limits have contributed to the significant reduction in point source phosphorus loading to the Chippewa River. This equated to an average loading of 11,575 kg/yr 2005 – 2008 compared to an average loading of 6,047 kg/yr during 2009 – 2014 (Appendix A). The difference suggests a 48% average reduction of phosphorus loading from point sources; however, samples collected in 2012 and 2013 were potentially compromised during laboratory analysis. Future sampling will confirm this decrease in phosphorus loading.

Figure 1. Chippewa River Watershed NPDES WWTFs.



Chippewa River Watershed

The Chippewa River Watershed drains 2,085 square miles spanning hillier, wooded areas in the northeast portion of the watershed to flatter, more agricultural areas in the southwest. The hillier areas tend to have more erosion compared to the flatter areas. Agriculture dominates the landscape comprising of mostly corn and soybean, in addition to small grains, hay and grasslands. The Chippewa River watershed monitoring and assessment report documents findings from the intensive watershed monitoring conducted in 2009 (MPCA, 2012). In addition, a watershed restoration and protection study, along with an implementation plan will be developed for the Chippewa River Watershed in the near future. Intensive watershed monitoring is expected to take place again in 2019. During the previous intensive watershed monitoring cycle eutrophication response variable data, namely chlorophyll-a (Chl-a), were not routine sample parameters.

River Eutrophication Standards

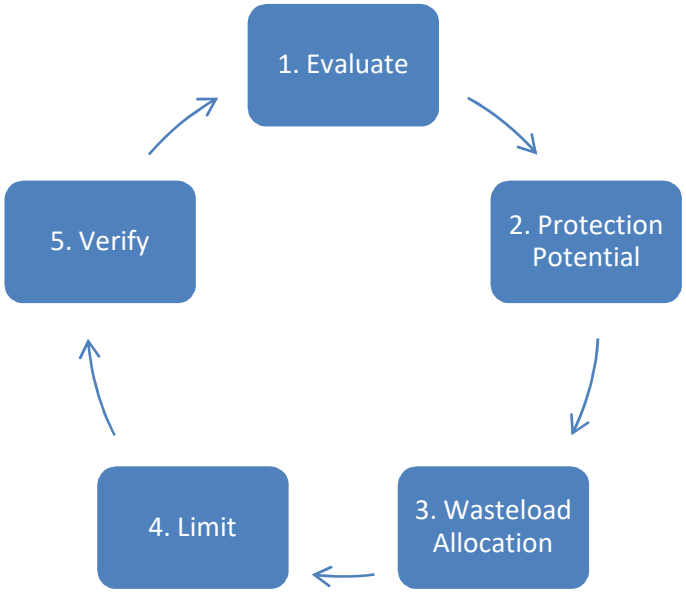
The Chippewa River is located in the South River Nutrient Region (RNR) and has a river eutrophication standard (RES) of ≤ 150 µg/L TP and ≤ 35 µg/L chlorophyll-a (Chl-a) (Minn. R. 7050.0222 https://www.revisor.mn.gov/rules/?id=7050.0222, Heiskary, 2013). Limited water quality data collected along the Chippewa River (07020005-508) indicate that RES causal criteria are being exceeded on a summer average basis (TP = 175 µg/L, n = 133). Additional response variable data are necessary to evaluate the potential for algae to grow in the Chippewa River. The potential for algae response cannot be evaluated with the limited number of Chl-a samples (Chl-a = 63 µg/L, n = 4). A formal review of RES criteria cannot be completed in the watershed because there is insufficient Chl-a data; however there is abundant TP data available. Additionally, there is no DO flux or BOD_5 data available for the watershed to complete a RES analysis on. Therefore, this analysis analyzes only the potential of WWTFs to exceed TP under permitted conditions.

All facilities, except Montevideo, are located upstream of flow and water chemistry data collection. Montevideo is located at the outlet of the Chippewa River Watershed and thus has minimal impact on its water quality. As a result, water quality calculations in the Chippewa River Watershed will exclude Montevideo. Instead, the Minnesota River Basin phosphorus effluent limit review (Minnesota River Basin) (Wasley, 2015) incorporates Montevideo WWTF into its analysis and limit determination.

The first downstream river reach with sufficient data to determine RES exceedance is the Minnesota River (AUID 07020007-503) downstream of the Chippewa River Watershed. The analysis on this reach is included in the Minnesota River Basin (Wasley, 2015) memo and will be discussed in further detail below.

A TP criterion analysis, following methodology described in MPCA, 2015, was conducted for the Chippewa River Watershed to determine if limits were appropriate for RES protection. An illustration of the iterative review process (Figure 2) and a brief description of the analysis conducted for the Chippewa River Watershed is outlined below.

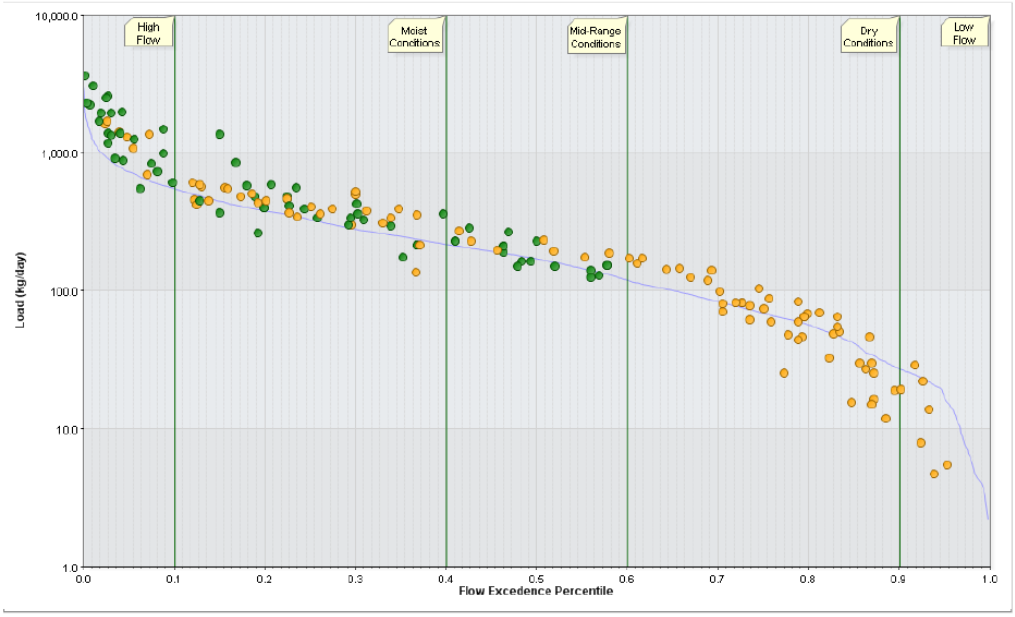
Figure 2. Overview of RES analysis and NPDES limit determination.



1. Evaluate

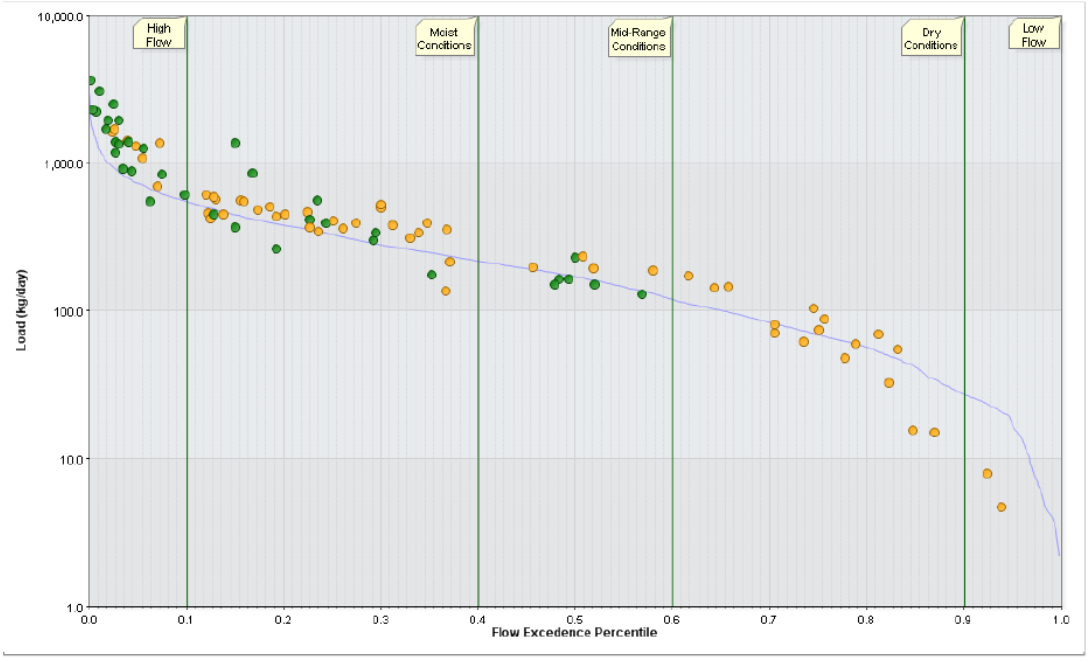
Limited TP and Chl-a samples (175 µg/L (n = 133) and 63 µg/L (n = 4), respectively) exceed RES criteria in the Chippewa River under long term summer average conditions. Given the low sample count for Chl-a, DO flux, and BOD_5, the MPCA cannot fully assess the eutrophication status of the Chippewa River. Nonetheless, effluent limit review staff conducted the five step process for the Chippewa River based on limits needed for downstream resources. To better understand the impacts on receiving waters from point sources, load duration curves were developed (Figures 3 and 4). Point sources can have a disproportionate impact on receiving waters during low flow conditions. Such conditions typically occur during summer months (June – September) when flow is equal to the 80^{th} percent flow exceedance (when, on average, 80% of the flow exceeds the respective flow value) (Wasley, 2014). The load duration curve representing historical water quality from 2004 – 2014 indicates water quality on average meets RES during the 80^{th} percent flow exceedance condition (TP = 147 µg/L) (Figure 3).

Figure 3. Chippewa River total phosphorus load duration curve representative of 2004 – 2014 water quality (S002-203) and flow conditions (USGS gage 05304500). Colors indicate seasonality of sampling as follows: green = June, yellow = July – September.



In addition, the load duration curve representing more recent water quality conditions (2009 – 2014) indicates TP loading has further decreased in concentration during the 80th percent flow exceedance condition (TP = 143 µg/L) (Figure 4).

Figure 4. Chippewa River total phosphorus load duration curve representative of 2009 – 2014 water quality (S002-203) and flow conditions (USGS gage 05304500). Colors indicate seasonality of sampling as follows: green = June, yellow = July - September.



2. Local Protection Potential

The reasonable potential (RP) for a facility to cause or contribute to an exceedance of eutrophication standards is evaluated at waters that have sufficient cause and response data. At these locations, facilities are considered to have RP if, while operating at capacity, they: 1) discharge at TP concentrations higher than the applicable eutrophication standard, and 2) the TP concentration of the primary water of interest exceeds RES. Even though Chl-a data were not sufficient to trigger a RP analysis for the Chippewa River Watershed, a TP criterion analysis was conducted with respect to sufficient TP data. Under most circumstances, a mass balance evaluation of point source loading is not conducted at sites without sufficient response data (Equation 1). However, in this circumstance, protection potential, the ability to achieve the causal criterion with limits, was evaluated as a means of validating whether limits set to meet downstream water quality are also sufficient to achieve more localized watershed goals. Most other major watersheds throughout the state have response variable sampling at the outlet and potentially multiple sub-watershed sites. The Chippewa River was one of the earlier major watersheds to receive IWM sampling at a time when response variable samples were not routinely collected. During the next IWM round, Chl-a will be sampled throughout the watershed, which will provide an additional basis from which to evaluate effluent limits. Nonetheless, an evaluation of the limits relative to the causal (TP) criterion at the watershed outlet is prudent for two reasons. First, pollutant load management from this watershed, as with a multitude of others, is necessary to meet downstream goals .Second, this watershed will receive more comprehensive response variable sampling during the next round of IWM sampling and therefore would be wise to validate the extent to which downstream limit protect localized waters. The following equation was used to calculate the potential of The Facilities to exceed the TP criterion in the Chippewa River in consideration of new limits to protect other downstream waters. This analysis accounted for preliminary plans for Murdock WWTF to regionalize with DeGraff, currently an unsewered community.

Equation 1. TP concentration of Chippewa River (S002-203) based on permitted flow for The Facilities.

$$Cr = \frac{QsCs + QeCe}{Qr}$$

Cr = downstream TP concentration of river at critical flow (80th percentile flow exceedance)
Qr = downstream river flow (80th percentile flow exceedance)
Qs = flow of river without WWTFs
Cs = concentration of river without WWTFs
Qe = design flow of WWTFs
Ce = long term effluent concentration, existing concentration limit or concentration target of mass limit

Qr = 99 mgd; based on permitted flow values and using Qr = Qs + Qe
Qs = 98 mgd; calculated using average daily flow from USGS gage at the outlet of the watershed during June – September at 80th percentile flow exceedance and subtracting The Facilities' average daily flow during June – September, 2009 – 2014
Cs = 0.13 mg/L; average TP concentration of the Chippewa River without contributions from WWTFs under low flow conditions
Qe = 1.5 mgd; 70% of permitted design flow
Ce = 1.1 mg/L; combination of permitted and actual effluent concentration

Cr = 148 µg/L TP

Because Cr meets RES criteria, it was determined The Facilities , with recommended limits as described more fully below, do not have the potential to cause or contribute to an exceedance of the phosphorus criterion in the outlet of the Chippewa River. Consequently, Step 3 (Wasteload Allocation) conducted for limit determination is not necessary. Step 4 (Limit) and 5 (Verify) will review current, proposed Minnesota River Basin, and Lake Pepin limits, in addition to current actual effluent concentrations when necessary, and confirm if existing controls are protective of waters downstream of the Chippewa River Watershed.

4. Limit

The TP criterion analysis demonstrates The Facilities do not need to have additional limits to protect for RES in the Chippewa River Watershed; however current concentration limits based on State Discharge Restrictions (SDR) Minn. R. 7053.0255 (https://www.revisor.mn.gov/rules/?id=7053.0255) are still applicable.

In addition, Wasley (2015) found The Facilities in the Chippewa River Watershed have RP to cause or contribute to the nutrient impairment in the Minnesota River Basin downstream of the Chippewa River. As such, WQBELs determined for the Minnesota River Basin will be applicable for The Facilities in the Chippewa River Watershed. It was determined that Lake Pepin WQBELs for select facilities were the same limit deemed appropriate for the Minnesota River (Table 2) (Wasley, 2015).

Table 2. Calculated Minnesota River TP daily WLAs for The Facilities.

	MN River Basin
Facility Domestic	June - Sept monthly average (kg/day)
Benson WWTP	4.9
Clontarf WWTP	[a]
Danvers WWTP	[a]
Evansville WWTP	[a]
Farwell Kensington Sanitary Dist WWTP	[a]
Hancock WWTP	2.5
Hoffman WWTP	[a]
Kerkhoven WWTP	2.1
Lowry WWTP	[a]
Millerville WWTP	A
Montevideo WWTPb	8.8
Murdock WWTP	[a]
Starbuck WWTP	1.8
Sunburg WWTP	[a]
Urbank WWTP	[a]
Watson WWTP	0.3
Industrial	
Chippewa Valley Ethanol Co	0.2[b]

[a]Lake Pepin mass limit sufficiently protective for Minnesota River Basin (Wasley, 2015)

[b]Routine effluent monitoring is recommended at this point. An effluent concentration typical of this type of facility was used to derive the MN River Basin limit. Future monitoring will confirm the final WQBEL protective for the Minnesota River.

5. Verify

The first river reach downstream of The Facilities with sufficient water quality data is the Minnesota River (AUID 07020007-503). This data was used in the analysis for the Minnesota River Basin memo which encompasses the Chippewa River Watershed (Wasley, 2015). The facilities within the Chippewa River Watershed were found to have RP to cause or contribute to the Minnesota River impairment. Therefore, protection of downstream waters for RES is ensured because WQBELs recommended for The Facilities in the Chippewa River Watershed are consistent with those recommended for the Minnesota River Basin. Additional monitoring may result in more restrictive limits in the future.

Lake Pepin

Effluent from NPDES WWTFs in the Chippewa River Watershed is discharged upstream of Lake Pepin, a riverine lake on the Mississippi River. In 2002, Lake Pepin was placed on the federal Clean Water Act Section 303(d) list of impaired waters due to excess nutrients. A total maximum daily load (TMDL) study for Lake Pepin is currently delayed, but a significant portion of the modeling analysis has been completed. Phosphorus is the primary nutrient responsible for excess algal growth in Lake Pepin. Federal law [40 CFR 122.44(d)] restricts mass increases upstream of impaired waters and states that all NPDES dischargers that have RP to cause or contribute to downstream impaired waters are required to

have a WQBEL. When determining RP, the Code of Federal Regulations also requires the use of procedures which account for existing controls on point and nonpoint sources of pollution. Permitees are found to have RP for TP if: 1) they discharge upstream of a nutrient impaired waterbody, 2) they discharge at TP concentrations greater than the ambient target (i.e. 0.100 mg/L), and 3) there is no geographical barrier capable of trapping a significant mass of nutrients between the outfall and the impairment during most streamflow conditions. For all reasons listed above, The Facilities discharging in the Chippewa River Watershed are found to have RP for TP upstream of Lake Pepin; and therefore required to have a WQBEL. WQBELs in the Chippewa River Watershed in combination with other point and nonpoint source reductions throughout the Lake Pepin Basin are sufficient to meet draft eutrophication standards in Lake Pepin. The draft standards were established to support the designated uses of this water resource.

A computer water-quality model for Lake Pepin was developed by MPCA modeling consultant, LimnoTech, to evaluate site specific eutrophication criteria and the reductions necessary to achieve these criteria (LimnoTech, 2009). Using the best available science, draft standards for Lake Pepin were determined to be 0.100 mg/L for TP and 0.028 mg/L for Chl-a (Heiskary and Wasley, 2012). Within the model, all major sources of TP upstream of Lake Pepin were considered, and 21 separate scenarios were developed. Scenario 21 achieved compliance with the draft criteria and predicted that the following TP reductions from tributaries would be necessary: HSPF modeled reductions from the Minnesota River, 50% from the Cannon River, 20% from the Mississippi River upstream of Lock and Dam 1 and 20% from the St. Croix River. During the modeling process, MPCA staff simultaneously developed draft WLAs, compatible with reductions in scenario 21 for all NPDES dischargers within the contributing basin of Lake Pepin. All simulations represented point sources on a 12 month basis.

Categorical WQBELs were developed for NPDES WWTFs in the Lake Pepin Basin. The limits require more reductions for larger WWTFs (Table 3). A categorical mass limit is calculated based on average wet weather design flow (AWWDF) or maximum design flow (MDF) and a categorical concentration multiplier (Tables 3 and 4). These limits have been implemented since 2010.

Table 3. Draft WQBELS for municipal and industrial WWTFs in the Chippewa River Watershed for Lake Pepin.

Facility (AWWDF or MDF*)	Components of mass limit to meet Lake Pepin WQBEL
Continuous > 20.0 mgd	AWWDF x 0.3 mg/L
Continuous 1.0 – 20.0 mgd	AWWDF x 0.8 mg/L
Continuous 0.2 – 1.0 mgd, Ponds > 0.301 mgd	AWWDF x 1.0 mg/L
Continuous <0.2 mgd	Maintain current discharge**
Stabilization ponds <0.301 mgd	Maintain current discharge**
WWTFs at conc. Below RES	Maintain current discharge***
Industrial Discharge with concentration > 1.0 mg/L	MDF x 1.0 mg/L
Industrial Discharge with concentration < 1.0 mg/L	Current load x 1.15
Other Industrial	Limits specified on a site specific basis

* MDF = Maximum Design Flow --> common value used to evaluate industrial discharges.
**Mass limits based on categorical concentration and AWWDF
***Expansion of these WWTFs may be permitted assuming effluent concentration remains below RES

Table 4. Calculated Lake Pepin annual WLAs for The Facilities.

Facility Type	2010-13 Average Load (kg/yr)	Lake Pepin WLA (kg/yr)
Chippewa River Watershed	**6,324**	**8,153**
Domestic	**6,271**	**8,110**
Municipal Major (<20,>1 mgd)	3,982	3,316
Large Municipals (<1,>0.202 mechanicals or 0.302 ponds)	750	1,774
Small Municipals (mechanical and <0.301 mgd)	1,147	1,929
Small Municipal Pond (pond and <0.201 mgd)	392	1,091
Industrial	**53**	**43**
Small Industrial High Concentration (<817 kg/yr and concentration >1.0 mg/L)	53	43

In total, SDR, Minnesota River Basin and Lake Pepin limits are all applicable for Chippewa River Watershed WWTFs in order to meet water quality standards in receiving waters. A summary of all appropriate TP limits and respective time frames is summarized in Table 5.

Table 5. Summary of applicable TP limits for The Facilities and corresponding time period.

	State Discharge Restriction[a]	MN River Basin	Lake Pepin
Facility	monthly concentration (mg/L)	June - Sept monthly average (kg/day)	12 - month moving total (kg/yr)
Domestic			
Benson WWTP	1.0[c]	4.9	1361
Clontarf WWTP		[e]	65
Danvers WWTP		[e]	63
Evansville WWTP	1.0[d]	[e]	138
Farwell Kensington Sanitary Dist WWTP		[e]	211
Hancock WWTP		2.5	884
Hoffman WWTP		[e]	439
Kerkhoven WWTP		2.1	725
Lowry WWTP	1.0[d]	[e]	61[f]
Millerville WWTP		[e]	54
Montevideo WWTP[b]		8.8	3316
Murdock WWTP		[e]	346
Starbuck WWTP	1.0[d]	1.8	414[f]
Sunburg WWTP		[e]	43
Urbank WWTP		[e]	30
Watson WWTP		0.3	121
Industrial			
Chippewa Valley Ethanol Co		0.2[g]	43[g]

[a]State discharge restriction limits based upon Minn. R. 7053.0255
[b]Montevideo limits from Minnesota River Basin memo (Wasley, 2015)
[c]12 – month moving average limit
[d]calendar month average limit
[e]Lake Pepin mass limits sufficiently protective for Minnesota River Basin
[f]TP mass limit consistent with draft Pope 8 Lakes TMDL (James et al., 2011)
[g]Routine effluent monitoring is recommended at this point. An effluent concentration typical of this type of facility was used to derive the MN River Basin and Lake Pepin limits. Future monitoring will confirm the final WQBELs protective for downstream waters.

Summary

This analysis demonstrates that limits developed to meet eutrophication standards in downstream waters, like the Minnesota River and Lake Pepin, are also sufficient to maintain the phosphorus criterion at the outlet of the Chippewa River (S002-203). The Facilities were evaluated at permitted effluent potential based on limited ambient data. As such, existing SDR limits are sufficient for the immediate receiving waters. Downstream of the Chippewa River Watershed, The Facilities have RP to cause or contribute to the excess nutrient impairment in the Minnesota River. In addition, The Facilities have RP to cause or contribute to the excess nutrient impairment in Lake Pepin. The Facilities are therefore required to have respective WQBELs. The recommended Minnesota River TP effluent limits (Table 2) were derived from an analysis for the greater Minnesota River Basin (Wasley, 2015), and limits to protect eutrophication standards in Lake Pepin will be compatible with future TMDL WLAs (Table 4). These values were developed from the water quality standards for the Minnesota River and Lake Pepin.

The limits are also sufficient to maintain the TP criteria for Chippewa River Watershed. An overview of all appropriate TP limits is summarized in Table 5. Finally, facilities should be aware that limits may be reevaluated in the future on the basis of additional new data in the Chippewa River Watershed.

References

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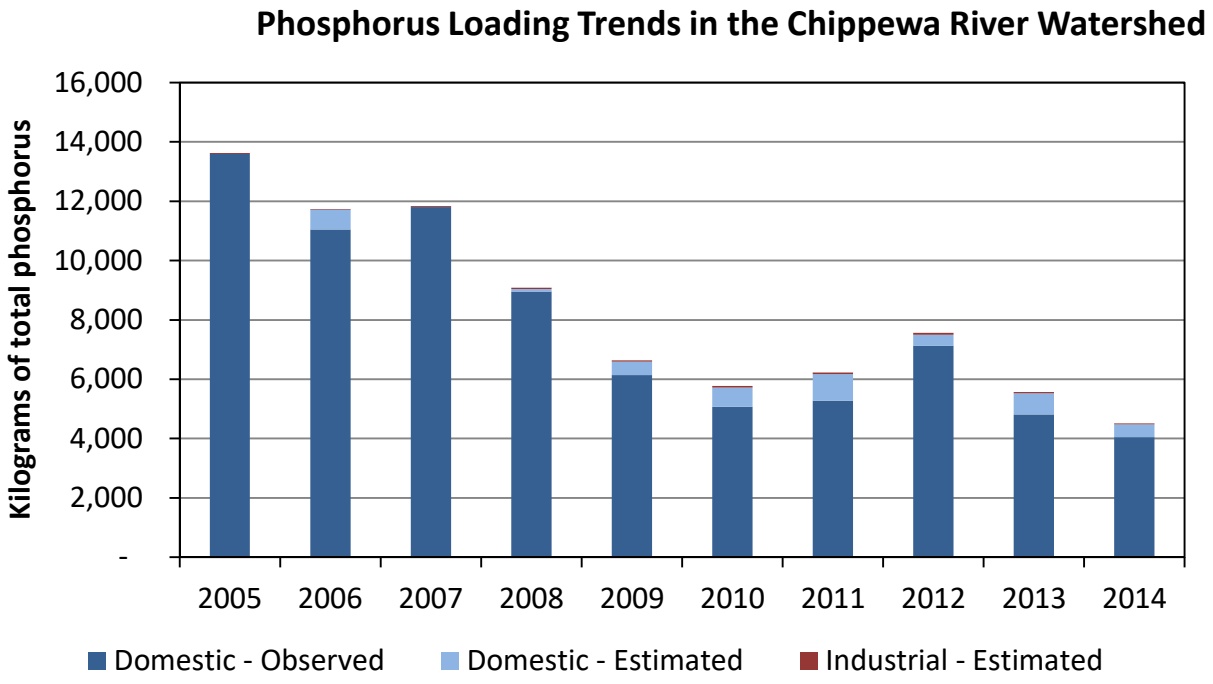
Appendix A


Phosphorus Loading Trends in the Chippewa River Watershed
Kilograms of total phosphorus
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Domestic - Observed
Domestic - Estimated
Industrial - Estimated